FLEXLAB

Facility for Low Energy eXperiments in Buildings

FLEXLAB for Building Façades – Use Case

Can we create optimized façades that provide comfort, daylight and net zero energy performance?

The Challenge

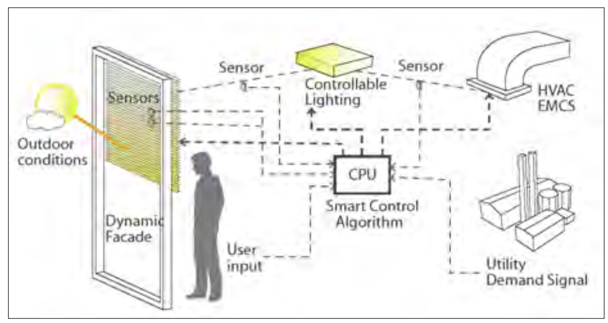
Optimizing the transparent elements in the building envelope to provide view and daylight, while minimizing winter heat loss, summer solar gain and glare, is a complex challenge. More stringent codes limit window size, but owners want large view windows. Dynamic solutions – smart glass, motorized shades and blinds, daylight redirecting systems – might help, but **there is enormous uncertainty in the actual performance of these dynamic systems.**

No one wants unproven solutions, but accurate field data are impossible to find. What do owners, designers, engineers, and manufacturers need to create smart and responsive façade and daylighting systems capable of **delivering net-zero energy performance, while minimizing peak cooling, maintaining view and providing visual and thermal comfort?**

FLEXLAB offers a unique opportunity for industry and researchers to collaboratively solve a wide range of performance integration and optimization problems. It allows **exploration of façade performance while varying and controlling every key design and operating parameter**: room parameters, façade features, occupied vs unoccupied, and HVAC/lighting interaction. Tests can be done in one-story spaces, two-story spaces or a rotating testbed that can be fixed in different orientations or moved to follow the sun.

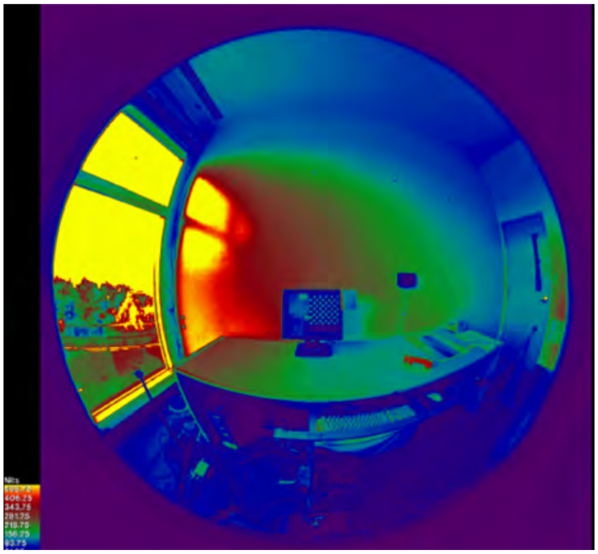
Starting Point

Imagine an innovative design team with a demanding client who wants a near net-zero building, with a radiant floor cooling system with limited peak perimeter cooling capacity. **The client demands a highly glazed façade to meet competitive market needs, and requires that comfort conditions be maintained in immediate proximity to the glazing to maximize rentable interior space.** A possible kit of parts includes: high performance glazing/framing, daylight redirecting technologies, dynamic glazing/shading, all coupled to smart lighting controls and responsive HVAC controls. But **numerous challenges arise that simulation tools alone cannot fully solve:** for example: can the radiant system handle peak cooling? How to optimize daylighting and glare tradeoffs by season and room location? How will occupants react to integrated controls?



Systems integration issues measured in FLEXLAB.

Testbed Capabilities	Performance Parameters and Benefits
Complete photometric capture throughout the room with dynamic HDR capability	Visual comfort – contrast, glare, ability to maintain worksurface illuminance
Exterior daylight conditions–cloud cover, irradiance, sun position	Impact of exterior conditions
Lighting system and fixture power	System energy use, and peak demand; resolved fixture by fixture, time dependent correlated to daylight
HVAC energy use	Peak cooling measurements; HVAC energy impacts
Reconfigurable interior spaces	Impact of changing workstations for user location and orientation vs. windows
Optimization of shading devices and operation	Compare systems across cells; optimized control of shading systems on energy (cooling/lighting) and thermal/visual comfort
Robust data acquisition, accommodation of additional instrumentation	Flexibility to integrate experiment-specific measurement with existing testbed sensors
Ability to interoperate and execute control across a variety of platforms and devices	Flexibility to test diverse systems and components, control solutions, and proprietary systems



Time lapse of interior room luminance with dynamic shading.

Solution Pathway

To rapidly assess options, the design team, in coordination with the owner and key suppliers, conducts a series of tests in two testbeds, each with two experimental rooms, over a nine-month period that captures peak summer and winter test conditions. With four different design conditions, **the team focuses on two solutions that optimize cooling and make daylight secondary, and two other solutions that optimize daylighting**. One pathway explores fully dynamic shading solutions with electrochromic glazing and motorized exterior blinds, while the others provide low-SHGC glazing with manual blinds, with an active daylight control solution in the clerestory to daylight the full depth of the space. One of the testbeds is the rotating facility – which allows low-sun west-facing façades to be compared to south facades. Current performance vs. goals are tracked in real time using the LBNL-provided dashboards. **Once the design solutions have converged towards performance goals, a series of short-term experiments are made with staff occupying the spaces to assess comfort and acceptance.**

Immediate Outcomes

- **Verification of basis of design** and that 70% energy savings goal can be accomplished.
- Comparative performance data on key design options allowing different design decisions to be made for glazing, shading, lighting, and HVAC.
- **Incorporate sequence of operations specified for control of shading, lighting and HVAC** into design specs.
- Insights into product improvements for **next -generation product development**.
- **Validation of simulation tools** over large performance range.
- **Occupant feedback** on system components and operational issues.
- Guidance for interior designers; **operating manual for occupants** based on test results.

Extended Validation & Deployment Opportunities

- **Extend results to other orientations and other climates** using the virtual controls testbed and EnergyPlus tools.
- Advise ASHRAE 189, 90.1, LEED and **other mandatory and voluntary rating and code** bodies on issues of dynamic vs. static equipment and impact on achieving goals.
- Update **NFRC ratings and labeling programs** for commercial façades and windows.
- Explore variability of occupant response to a wider range of dynamic solutions and space layouts.
- Explore **alternate HVAC solutions** and integration schemes.
- Explore private office vs. open landscape design implications.
- Build partnerships with **early-adopter testbed members** to conduct scaled demonstrations in real-world buildings across the nation.

References and Further Reading

Lee, ES, Selkowitz, S, et al. High Performance Building Facade Solutions. PIER Final Project Report. 2009. LBNL-4583E. Available from: http://lowenergyfaçades.lbl.gov/

Konis, K, Lee, ES, Clear, RD. 2010. Visual Comfort Analysis of Innovative Interior and Exterior Shading Systems for Commercial Buildings using High Resolution Luminance Images. Leukos, Journal of the Illuminating Engineering Society of North America 7(3): 167-188. LBNL-4417E.